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# INVESTIGATION OF POLLUTION IN THE MISSOURI RIVER. AS AGGRAVATED BY GARBAGE DUMPING AT OMAHA, NEBRASKA

Public Health Service
Washington, D.C.

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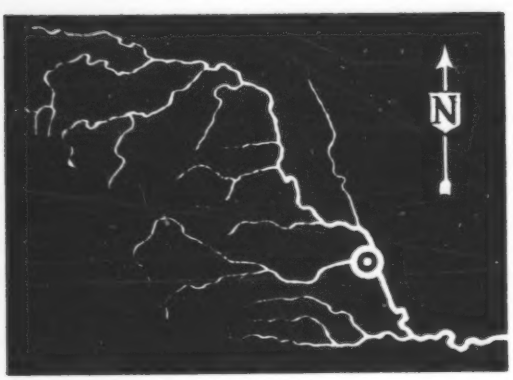
# *Investigation of Pollution in the Missouri River*

## As aggravated by Garbage Dumping at Omaha, Nebraska

October 29, 1952

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U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE---Public Health Service

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## I. INTRODUCTION

On or about September 15, 1952, the City of Omaha, Nebr., announced its intention of initiating disposal of garbage by sewered discharge to the Missouri River. The city council of Nebraska City, Nebr., on September 15, 1952, enacted and transmitted to the Public Health Service a resolution advising of alarm and concern regarding the influence of this disposal program upon the quality of water serving as the source of its public supply. Also, on September 15, the Nebraska State Health Department advised the Missouri Drainage Basin Office, Public Health Service, of the interest of Val Peterson, Governor of Nebraska, in securing adequate investigation of the resulting pollution, and requested assistance of the Public Health Service in an investigation of the influence of this pollution on downstream water supplies, with particular reference to Nebraska City, Nebr.

Discharge of garbage into the Missouri River at Omaha was initiated on September 17, 1952.

## II. AUTHORITY

Specific authority for the Public Health Service to conduct investigations relating to pollution is contained in the Federal Water Pollution Control Act, Public Law 845, 80th Congress, as amended by Public Law 579, 82nd Congress. Cooperative and advisory assistance to State Health Departments is also authorized by the Public Health Service Act, Public Law 410, 78th Congress.

## III. METHODS AND PROCEDURES

Contact was made with the State Sanitary Engineer on September 18, to discuss immediate steps to be taken pending detailed evaluation of the situation. On September 20, Dr. E. A. Rogers, State Health Officer, Mr. T. A. Filipi and Mr. L. O. Vose, Directors of the Divisions of Sanitation and Laboratories, respectively, and the Officer in Charge, Missouri Drainage Basin Office, Public Health Service, conferred in Lincoln, Nebr., and completed arrangements for a cooperative investigation of the pollution problem. Functions and responsibilities were divided as follows:

1. The Division of Sanitation would collect samples of water from the Missouri River at Bellevue and Nebraska City, Nebr., and from potable water treatment plant effluents at Nebraska City and the Bellevue power plant, and transport the samples to Lincoln, Nebr., for analyses.

2. The Division of Laboratories would conduct, in accordance with standard methods, the laboratory analyses of stream samples, including determinations for coliform group organisms (M.P.N. per 100 ml.) B.O.D. (5 day, 20° C), and chlorine demand, and standard bacteriological analyses of samples from water treatment plants.

3. The State Health Officer would maintain liaison with local practitioners and obtain reports of an unusual incidence of disease in the Nebraska City area attributable to or associated with an unsafe water supply, and would distribute the report of the investigation to the Governor of the State, to the City of Nebraska City, and to others as deemed advisable.

4. The Public Health Service would (a) observe physical conditions of the stream, and obtain pertinent information regarding garbage discharged, stream flow, operating problems at water plants, and other water uses influenced by the pollution, and (b) prepare a suitable report of the investigation based upon laboratory data from previous studies and the current investigation, and information obtained from field observations.

## IV. LABORATORY FINDINGS

Laboratory analyses of samples of treated water collected daily at Nebraska City and at the Bellevue power plant revealed an absence of organisms of the coliform group. Such findings are generally interpreted as meaning the water supply is safe bacteriologically at the time of collection.

Tables 1, 2, and 3 (pages 15 - 20) reflect pertinent laboratory data for river water at Omaha, the Bellevue power plant, and Nebraska City for the period of study, and a comparison with similar information obtained about two years ago during a survey of the lower Missouri River by the State Health Departments of South Dakota, Iowa, Nebraska, Kansas and Missouri in cooperation with the Public Health Service.

Table 4 (page 21) contains total bacteria count (37°C) data obtained from the St. Joseph, Mo., water plant. These data are illustrated in plate 1.

Analyses of data in table 1 indicate that pollution above Omaha as measured by median values of coliform organisms and B.O.D.,

while somewhat below records for 1950, is of the same level of magnitude as existed during 1950 under comparable stream flow. Data in tables 2 and 3 indicate that median values of coliform organisms (M.P.N.) at Bellevue and Nebraska City increased considerably over levels found in 1950 during periods of comparable stream flow. Tables 2 and 3 also indicate that median B.O.D. values at Bellevue and Nebraska City increased substantially over levels found in 1950 during periods of comparable stream flow. These data reflect pollution from disposal of garbage into the river. Table 4 reveals a noticeable increase in total bacteria (37°C) in river water being processed at the St. Joseph, Mo., water plant during the period of sewered disposal of garbage. Stream flow during the period of observations was in the range of 25,000 to 35,000 c.f.s. Time of passage in the Missouri River from Omaha, Nebr., to St. Joseph, Mo., at prevailing stream flow is estimated as 3-1/2 days.

Acknowledgment is hereby tendered the Nebraska State Health Department for collection, transportation, and analyses of samples from Bellevue and Nebraska City. Acknowledgement is also given to the Metropolitan Utilities District, water department, and to the St. Joseph, Mo., water department for sample collection and laboratory analyses at Omaha, Nebr., and St. Joseph, Mo., respectively. The Public Health Service did not participate in laboratory operations.

## V. FIELD OBSERVATIONS

### A. Waste Discharges

Garbage disposal at Omaha by sewered discharge to the Missouri River began on September 17. About 80 tons of garbage were dumped daily from trucks into sewer manholes located at 4th and Jones Streets and at 25th and "Y" Streets. In addition to the garbage, wastes from large poultry packing establishments were dumped into the sewer at the 4th and Jones manhole. Poultry packing wastes are estimated to include daily about 9 tons of entrails, dead fowl, feathers, etc., although on occasions the amount of this refuse may be increased three or fourfold. This practice of dumping poultry packing refuse into the sewers has been carried on for some time, and a report covering this aspect of pollution was provided the State Health Department on September 7, 1951. Other wastes from the Omaha area include domestic sewage from a population of about 225,000 and industrial wastes estimated as equivalent organically to the wastes from a population of 1,350,000. Industrial

wastes of importance include those from the extensive meat, poultry packing, and dairy products establishments, and the wastes from a furfural plant. Wastes normally discharged in the Omaha area are thus estimated to approximate 1,600,000 population equivalents. The pollution from garbage must be considered as an addition to this existing pollution load.

Garbage discharged through the sewers is clearly evident in the vicinity of the outfalls. Accumulations of floating materials ease into the flowing stream and are gradually dispersed by the current. Much of the garbage moves downstream beneath the surface of the water. Eddy currents and wind action concentrate much of the material along the stream banks, particularly when wind action is pronounced. While shifting currents and wind action may remove these deposits eventually, unsightly appearances and objectionable odors result. These conditions are portrayed by figures 1 and 2. Garbage readily recognizable as such was observed in the river at Nebraska City, and has been reported at Rulo, Nebr.

Packing house wastes include blood, paunch manure, offal, scraps, and grease. Offal was observed in several instances, and even an entire hog at the South Omaha sewer outlet. These conditions are reflected in figures 3, 4 and 5. Private scavengers salvage grease from packing house wastes in a crude facility located at the terminus of the South Omaha outfall sewer, but removal is grossly inadequate. Large accumulations of grease were observed on the river surface below the Omaha sewer outfall and are shown in figure 6. Floating grease was observed as far downstream as Nebraska City by Public Health Service personnel assigned to this study, and was reported by a sportsman from Falls City, Nebr., to exist near Rulo, Nebr., about 117 river miles below Omaha.

## B. Water Uses

Primary water uses below Omaha are as follows:

1. Cooling and potable water at the Bellevue, Nebr. power plant, located about 8 miles downstream from Omaha, where large volumes of river water are used for cooling purposes and river water serves as a source of drinking water for about 80 people--after treatment consisting of sedimentation, prechlorination, lime and alum precipitation using the accelerator process, pressure filtration with anthracite media, and pH rectification with sulphuric acid.

2. Municipal water supply at Nebraska City, a city of approximately 6,500 population located about 52 miles downstream from Omaha, where Missouri River water serves as the source of supply after treatment consisting only of prechlorination, coagulation, sedimentation and postchlorination.

3. Navigation, industrial water supply, fishing by commercial operators and individual sportsmen, and limited water recreation. Commercial fishermen and sportsmen have voiced objections to garbage pollution as far downstream as Rulo, Nebr., 117 river miles below Omaha.

C. Effects of Pollution

Screens at the cooling water intake at the Bellevue power plant retain considerable quantities of garbage and poultry packing refuse, as is shown in figure 7. While power production has not been interrupted or curtailed, operating problems are increased, including cleaning of screens and disposal of screenings. Of much greater importance is the fact that the cooling water intake serves as the source of water supply for about 80 people. The intimate and recent contact of water entering the treatment plant with garbage, sewage, and industrial waste results in pollution difficult to absorb, with complete safety, even by the most modern water treatment plant.

A similar condition exists at the Nebraska City water plant. Accumulations of garbage, grease, and poultry packing refuse must be removed daily from the clarification basins of this water plant. Included in this material on September 19 was a duck's head, fully intact, as shown in figure 11, reproduced from a photograph furnished by the Nebraska City utilities company. Figures 9 and 10 show an orange peel and a partially decomposed rat stranded immediately adjacent to the water works intake at Nebraska City. Figure 8 shows an accumulation of grease on the intermediate settling basin of the Nebraska City water plant.

Problems of operation and of control of objectionable taste and odors at the Nebraska City water plant were intensified during the period that disposal of garbage was accomplished through sewers. Great alarm was apparent among citizens in Nebraska City regarding the safety of the public water supply, and the ability of the water plant to process a safe water in view of the additional pollution load

resulting from garbage disposal into the Missouri River. Many families in Nebraska City discontinued use of the public supply for drinking purposes and turned to private water supplies in the rural areas. Citizens of Nebraska City complained of a greasy film on utensils in which boiling of water was involved and upon baby feeding bottles sterilized in boiling water. This greasy film was reported to be apparent only after sewered disposal of garbage was initiated.

A commercial fisherman operating in the vicinity of Pacific Junction, Iowa, 32 miles below Omaha, Nebr., reported his nets fouled with garbage and his catch substantially reduced. Another commercial fisherman operating between Bartlett and McPaul, Iowa, about 33 and 39 river miles, respectively, downstream from Omaha, reported similar conditions. The Regional Engineer, Iowa Department of Health, observed considerable floating material of the nature of garbage on the river at a point below Pacific Junction. Objectionable odors, surface slimes, and nuisance conditions on the Missouri River in the vicinity of Rulo, Nebr., 117 miles downstream, were reported by a resident of Falls City who had fished on the river near Rulo. Interest and concern regarding pollution from garbage has been voiced by the State of Iowa, Department of Health.

An employee of the Corps of Engineers reported that after garbage dumping into the river was initiated, timber piling in the vicinity of Plattsmouth, Nebr., 24 river miles downstream from Omaha, became coated with a greasy slime, rendering footing and manual operations hazardous and increasing the probability of accident. Corps of Engineers employees reported considerable floating and stranded garbage between Omaha and Peru, Nebr., 72.9 miles downstream.

## D. Alternate Method of Disposal

Concurrent with the sewered disposal of garbage, research and investigations were initiated regarding the feasibility of processing garbage for livestock feed or fertilizer through an existing industrial plant in Omaha. The plant, formerly producing alcohol from grain but recently closed, offered excellent potential for this use, as facilities were already available for heating and processing garbage to provide for its sanitary disposal with conservation of a portion of its organic constituents.

After about two weeks of study and experimentation, the company entered into an agreement with the City of Omaha whereby garbage disposal would be handled in the former alcohol plant by conversion to by-products as livestock feed. Reportedly the contract will be effective until January 1, 1954. Sewered disposal of garbage was terminated on October 9, 1952.

## VI. DISCUSSION

The sewered discharge of garbage in the Omaha area resulted in a substantial increase in the total pollution discharge from the area, as measured in terms of organic materials. As garbage contains much floating material, resulting pollution is much more apparent than the far greater organic load from domestic sewage and industrial wastes from the area. Also, nuisance conditions from decomposing organic materials accumulated by wind or current action are much more extensive and more readily apparent than results from domestic sewage and industrial wastes.

Poultry packing refuse in many respects provides pollution comparable to that resulting from discharge of garbage. While of lesser volume, the poultry wastes represent greater pollution per unit of weight, and feathers, not readily decomposable, travel very far downstream. Pollution from the garbage, measured either in terms of coliform bacteria or in terms of Biochemical Oxygen Demand , is much smaller than that from the domestic sewage or from the industrial wastes from the Omaha area. Garbage, however, is a particularly objectionable type of pollution in that it is discharged in slugs; contains floating materials and substances that carry extremely far downstream without decomposition; and nuisance conditions from objectionable odors and unsightly accumulation of floating materials occur frequently. Such accumulations provide food for rodents, and promote fly breeding. Further, there are economically feasible methods of garbage disposal proven to be sanitary and free from nuisance.

The most important aspect of pollution from Omaha is its effects on domestic water supplies at the Bellevue power plant and at Nebraska City, and to a lesser extent on domestic water supplies taken from the river further downstream. Sewered disposal of garbage at Omaha, Nebr., resulted in increased and more variable concentrations of organic matter in solution, as evidenced by laboratory analyses of samples collected at the intake of the water plant at

Bellevue power plant and at Nebraska City, as compared to similar data obtained in 1950 under comparable conditions of stream flow. Increase in B.O.D. at each water plant and variations therein are reflected in increased and more variable chlorine demand. Water serving as the source for these two treatment plants must be considered as dilute sewage. This presents problems of public health protection, water treatment plant operation, and control of objectionable taste and odors. The situation at Nebraska City is further complicated in that the water plant does not provide conventional treatment and is overloaded and obsolete.

Information from the St. Joseph, Mo., water plant reveals that the effects of garbage pollution extended to that locality as a substantial increase in total bacterial count (37°C) followed the discharge of garbage through sewers at Omaha. After termination of sewered discharge of garbage, the total bacterial counts gradually lowered.

While bacteriological analyses of finished water at the three water purification plants, during this investigation, did not reveal contamination by bacteria of the coliform group, a health hazard is definitely presented because the overload already existing on the water plants was materially increased. Also the chances of failure in purification processes are materially increased, because of possible faulty operation or mechanical failure of equipment as chlorinators, and possible failure in the human element of supervision and maintenance. Further, methods of water analyses, as normally used for evaluation of public water supplies, reflect only contamination by bacteria of the coliform group. Pathogenic bacteria not of the coliform group, as well as the several viruses known to be contained in sewage, are not detected in normal water analyses. Soluble matter from sewage, industrial wastes or garbage may not be removed by conventional water treatment facilities, particularly where plant facilities are incomplete, overloaded, or obsolete as at Nebraska City. The sanitary requirements for raw water as included in the Manual of Recommended Water Sanitation Practice, Public Health Bulletin No. 296, 1946, the generally accepted tolerance limit of coliform bacteria that can be consistently handled safely by a modern water treatment plant, are grossly exceeded at Nebraska City and at the Bellevue power plant. The use by residents of Nebraska City of private rural water supplies because of objectionable tastes and odors, and lack of confidence in the public supply, constitutes a definite health hazard, as private water supplies very frequently are unsafe.

Since disposal of garbage to the Missouri River at Omaha was initiated an increase in the incidence of intestinal disturbances, virus infections, and other illness in which contaminated water may be a contributing factor, has been reported by physicians practicing in Nebraska City. These reports of increased morbidity were received by the Public Health Service on October 27, 1952. The significance of an increase in morbidity as reported cannot be properly determined without supporting epidemiological studies.

Nuisance is constituted by unsightly accumulations of floating or stranded garbage along the banks of the river and on sand bars, and by the unpleasant odors accompanying the decomposition of these accumulations. Such accumulation provides food for rodents and promotes fly breeding. Also in the nuisance category are floating accumulations and objectionable odors at Rulo, Nebr., as reported by sportsmen from Falls City, Nebr. Further, slime coating of piling represents an occupational hazard to river workers concerned with construction and maintenance of navigation and bank stabilization works. In addition, fouling by garbage of nets of commercial fishermen is a real damage to these individuals.

Fouling of fish nets by garbage, nuisances from unsightly accumulations of garbage and odors from their decomposition, and occupational hazards to river workmen have been reported by residents of Iowa. If the discharge of garbage at Omaha were continued, or is resumed with effects as described above, we believe the courts would construe these conditions to constitute interstate pollution, subject to abatement by the Federal government under the Federal Water Pollution Control Act, Public Law 845, 80th Congress, as amended by Public Law 579, 82nd Congress. The increase in total bacteria count ($37^{\circ}C$) at the St. Joseph, Mo., water plant, if resulting from discharge of garbage, may also constitute an interstate problem.

While primary responsibility for abatement of pollution originating in Nebraska rests with the State of Nebraska, the State does not have comprehensive water pollution control legislation. The State Attorney General is understood to have advised State officials that action to abate the subject pollution could not be initiated until it had been demonstrated that a health hazard clearly existed. By the time investigations and accompanying laboratory work necessary to demonstrate existence of a health hazard had been completed, disposal of garbage by river discharge had been terminated. This experience clearly demonstrates the imperative need for comprehensive water pollution control legislation in Nebraska covering all legitimate water

uses, and placing adequate powers in a State water pollution control agency and authorizing such agency to take reasonable action in an emergency such as this situation.

The termination of garbage discharge by sewers has largely obviated fouling of fishing nets, nuisance conditions from floating or stranded accumulations of garbage, and the increase in total bacteria (37°C) experienced at the St. Joseph water plant. It will not, however, obviate the high coliform count, or the problems of taste and odor control and related problems of operation of water supplies at Nebraska City and the Bellevue power plant resulting from pollution caused by existing sewage and industrial wastes at Omaha. Floating grease from industrial wastes at Omaha are still apparent in the settling basins at the Nebraska City water plant, and grease film on cooking utensils, although less severe, is reported to continue. Feathers, meat scraps, and other refuse from poultry and livestock packing establishments plagued water plant operations at the Bellevue power plant and at Nebraska City before garbage dumping was initiated, and continue to do so after such dumping has been discontinued. The raw water serving these two water plants using Missouri River water must be considered to constitute a potential public health hazard before and after river disposal of garbage was practiced. During the period of river disposal of garbage, the degree of the hazard was somewhat intensified.

While garbage disposal by discharge into the river at Omaha has been terminated, reduction of pollution from domestic sewage and industrial wastes will require considerable time for planning, financing, and construction. Interceptor sewers will be necessary to collect sewage from numerous outfalls and transport the waste to a central treatment plant. While an expenditure of several million dollars would be involved, the annual cost per capita to citizens of Omaha in providing sewage treatment would at most be a few cents per day. The per capita cost of sewage treatment at Omaha would be no greater than the per capita expense borne by citizens of numerous small cities in Nebraska which have already provided adequate treatment for sewage and industrial waste originating in these small towns. Much can be accomplished in the Omaha area in reducing industrial pollution through improved programs of waste salvage, by-product recovery, careful operation, and waste prevention. There is no valid excuse for the discharge into the sewer system of enormous amounts of blood, grease, offal, paunch manure, feathers, animal and fowl carcasses, and similar materials from livestock and poultry packing establishments.

Other communities (and industries) along the stream reach under consideration, as Carter Lake, and Council Bluffs, Iowa, and Nebraska City, Bellevue, and Plattsmouth, Nebr., do not provide sewage treatment. Omaha, Nebr., and its industries produce an overwhelming portion of the total pollution, and must therefore receive first consideration in any program for alleviating pollution of this section of the river. Other communities should then proceed with abatement programs. Council Bluffs, Iowa, has already completed design plans for its waste treatment plant.

## CONCLUSIONS

As a result of this field investigation it is concluded that:

1. The disposal of garbage at Omaha by sewered discharge to the Missouri River substantially increased the excessive pollution load already existing from domestic sewage and industrial wastes.

2. Pollution originating in the Omaha area adversely affects water quality and plant operation at water treatment plants serving the Bellevue power plant at Nebraska City. Garbage increased the adverse effects of pollution. Deteriorated water quality through increased bacteriological contamination is also reported from St. Joseph, Mo. While an increase in morbidity possibly attributable to contaminated water has been reported by physicians in Nebraska City, substantiating epidemiological investigations of the reported illness have not been made.

3. Nuisance conditions resulted at numerous places from the accumulation and decomposition of floating or stranded garbage.

4. Legitimate water uses as commercial fishing and water recreation were adversely affected by the sewered disposal of garbage to the Missouri River.

5. If the continued or resumed discharge of garbage at Omaha results in the fouling of fish nets, occupational hazards to river workmen and nuisance conditions as reported from Iowa, and deteriorated water quality as reported at the St. Joseph, Mo., water works, we believe the courts would construe such conditions to constitute interstate pollution subject to abatement by the Federal government under the Federal Water Pollution Control Act, Public Law 845, 80th Congress, as amended by Public Law 579, 82nd Congress.

6. Pollution of the Missouri River by sewage and industrial

wastes from the Omaha metropolitan area, without the additional pollution resulting from disposal of garbage to the river, constitutes a potential health hazard in connection with domestic water supplies at Nebraska City and at the Bellevue power plant.

7. Laws of Nebraska relating to control of water pollution are inadequate to permit reasonable control of pollution with respect to protection of public health, prevention of nuisances, conservation of fish and aquatic life, and protection of other legitimate water uses.

8. The water treatment plant at Nebraska City is grossly inadequate to process Missouri River water and continuously supply a safe, palatable water, free from taste, odor, grease content and other objectionable characteristics.

## RECOMMENDATIONS

It is recommended that:

1. The City of Omaha refrain from further discharge of garbage into the Missouri River.

2. The discharge of livestock and poultry packing offal, including feathers, dead animals, and fowl, into the sewers be immediately discontinued.

3. The City of Omaha and industries in the area initiate immediate action to facilitate the construction at the earliest possible date of adequate works for the treatment of domestic sewage and industrial wastes.

4. Nebraska City initiate immediate action to facilitate the construction of a modern water treatment plant at the earliest possible date.

5. Comprehensive legislation necessary for an effective program of prevention and control of pollution in Nebraska be enacted by the legislature during its next session.

GLEN J. HOPKINS
Officer in Charge
Missouri Drainage Basin Office
U. S. Public Health Service

Figure 1. Garbage, sewage and industrial wastes entering Missouri River at Omaha follows west bank until dispersed by current and wind action. (Highway bridge at Omaha in background).

Figure 2. Nuisance results from unsightly appearance and odors of decomposition of garbage and industrial wastes stranded short distance downstream from Omaha.

Figure 3. Blood and grease in sewage from South Omaha sewer as it enters the Missouri River.

Figure 4. Hog carcass in South Omaha outfall sewer.

Figure 5. Garbage, blood, offal, grease, and hog carcass in sewage from South Omaha enters Missouri River without treatment.

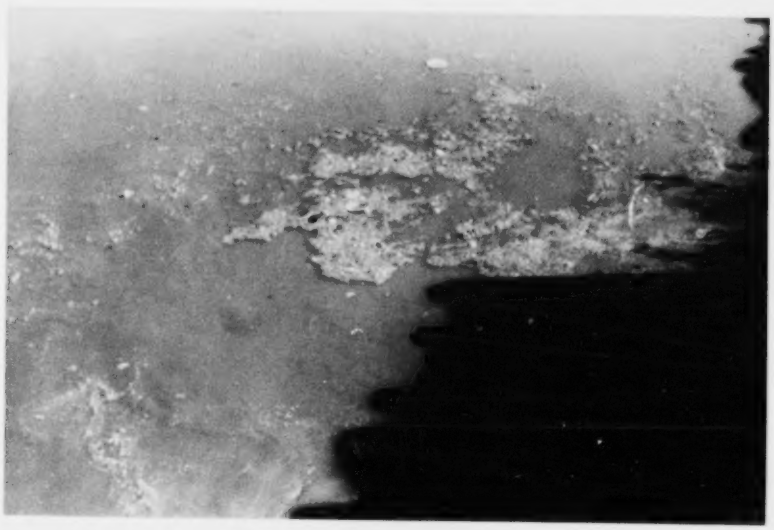


Figure 6. Accumulation of garbage and congealed grease floating downstream from Omaha.

Figure 7. Sewage, garbage and poultry wastes retained on traveling screens of water intake at Bellevue power plant (8 miles downstream from Omaha). Water from intake also serves treatment plant providing domestic water for about 80 people.

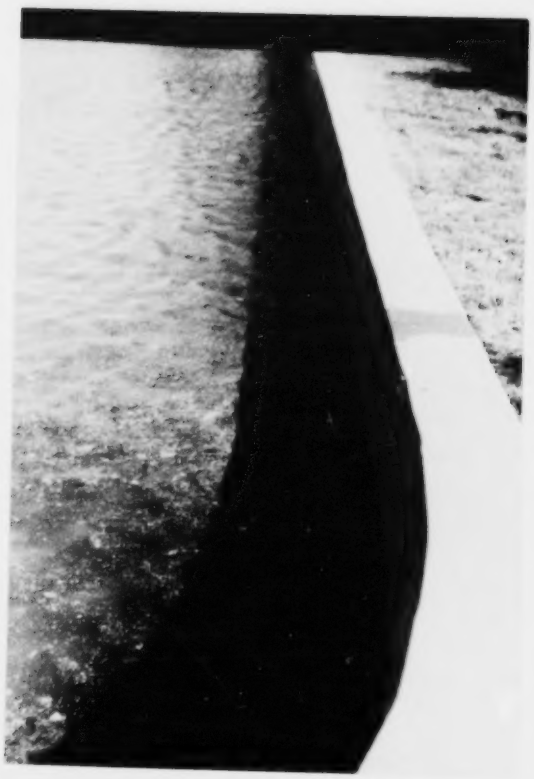


Figure 8. Grease retained in final settling tanks of water treatment plant at Nebraska City (population about 6,500, 52 miles downstream from Omaha). Treatment following this stage of purification limited to postchlorination.

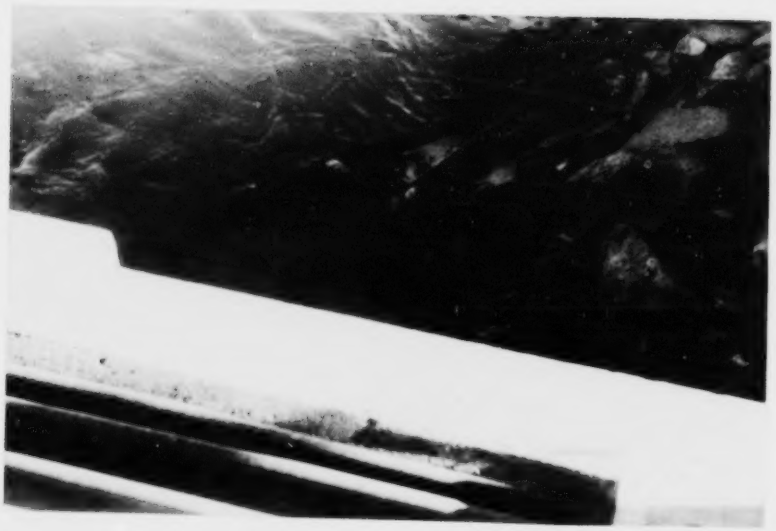


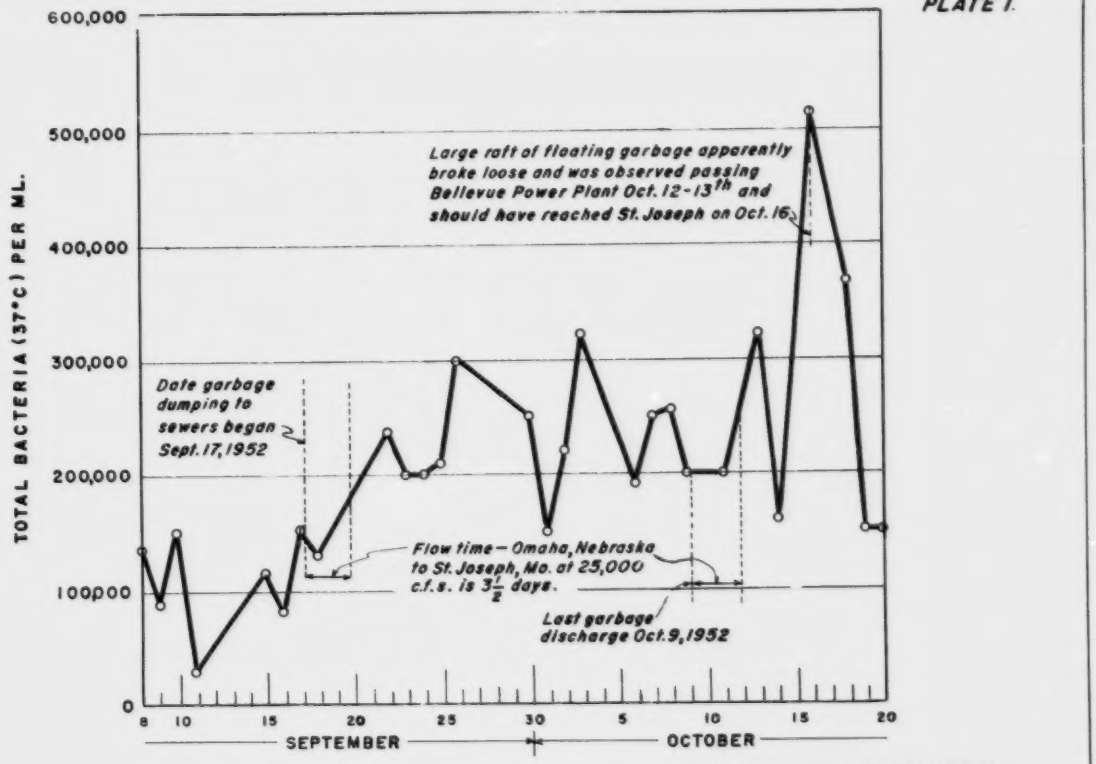
Figure 9. Semidecomposed rat and orange peel stranded on rocks near intake of Nebraska City public water supply.

Figure 10. Enlarged view of dead rat and deposited garbage near intake of Nebraska City water plant.

Figure 11. Refuse collected from Nebraska City water plant (September 19, 1952) -- observed by representative of Public Health Service -- included, among other things, feathers, vegetable scraps, fruit rinds, scraps of meat and offal, and duck's head, fully intact.

(Photograph of Nebraska City water department)

PLATE I.


600,000
500,000
400,000
300,000
200,000
100000
0
TOTAL BACTERIA (37°C) PER ML.
Large raft of floating garbage apparently broke loose and was observed passing Bellevue Power Plant Oct. 12-13th and should have reached St. Joseph on Oct. 16
Date garbage dumping to sewers began Sept. 17, 1952
Flow time – Omaha, Nebraska to St. Joseph, Mo. at 25,000 c.f.s. is 3½ days.
Last garbage discharge Oct. 9, 1952
8 10 15 20 25 30 5 10 15 20
SEPTEMBER
OCTOBER

TOTAL BACTERIA (37°) PER ML.
ST. JOSEPH, MO. WATERWORKS INTAKE
SEPT. 8 THROUGH OCT. 20, 1952
Laboratory Data From
ST. JOSEPH, MO. WATERWORKS

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# GLOSSARY

| | |
|---|---|
| 1. Coliform Group Organisms | A group of bacteria, predominantly inhabitants of the intestine of man but also found on vegetation, including all aerobic and facultative anaerobic gram-negative, non-spore-forming bacilli that ferment lactose with gas formation. This determination gives the most accurate estimation of the degree of pollution by sanitary sewage as these organisms are discharged in vast numbers in human feces which constitute the main source of these bacteria in sewage. |
| 2. Most Probable Number (M.P.N.) | In the testing of bacterial density by the dilution method, that number of organisms per unit volume which, in accordance with statistical theory, would be more likely than any other possible number to yield the observed test result or which would yield the observed test result with the greatest frequency. Expressed as density of organisms per 100 milliliters. |
| 3. Biochemical Oxygen Demand (B.O.D.) | The parts per million (ppm) of oxygen required for stabilization of putrescible organic matter by aerobic digestion. The standard test for biochemical oxygen demand requires five days incubation in total darkness at 20°C of sealed samples of water under examination and the determination of the loss of dissolved oxygen during that time. The B.O.D. thus determined becomes a measure of the amount of oxygen necessary to satisfy the bacterial oxidation requirements of the pollution present at the time the sample was collected. |

| | |
|---|---|
| 4. The Chlorine Demand | The difference between the amount of chlorine added to water, sewage, or industrial wastes and the amount of residual chlorine remaining at the end of a specified contact period. The chlorine demand for water will vary according to concentration of organic matter and chemical substances present, the amount of chlorine applied, and the temperature. |
| 5. Total Bacteria ($37^{\circ}$C Standard Agar Plate Count) | This represents the number of bacteria developing from the incubation of a sample of water at $37^{\circ}$C on a standard agar plate. A sample of water, or dilution thereof, is placed in a petri dish and incubated in a dark, moist, well-ventilated atmosphere with nutrient agar at $37^{\circ}$ C for 24 hours. Bacteria growing on the plate and counted with a lens giving a magnification of 1-1/2 diameters, are the total bacteria developing on nutrient agar at $37^{\circ}$C and represents those which are accustomed to the temperature of the human body. |
| 6. Cubic Feet per Second (c.f.s.) or Second Feet | A measure of the rate of discharge relating volume to time. |

Table 1.

Florence pumping station (Omaha, Nebr.) laboratory data 1950[a]

| Day (1950) | B.O.D. (ppm.) | Coliform (M.P.N./100 ml.) | Missouri R. discharge (c.f.s.) |
|---|---|---|---|
| Sept. 13 | 0.7 | 46,000 | 30,000 |
| 14 | -- | 46,000 | 29,300 |
| 15 | -- | 24,000 | 29,300 |
| 16 | -- | 46,000 | 25,800 |
| 17 | -- | 24,000 | 30,000 |
| 18 | -- | 24,000 | 30,000 |
| 19 | -- | 46,000 | 31,400 |
| 20 | 1.0 | 46,000 | 30,700 |
| 21 | -- | 46,000 | 31,400 |
| 22 | -- | 110,000 | 35,500 |
| 23 | -- | 46,000 | 37,000 |
| 24 | -- | 24,000 | 40,000 |
| 25 | -- | 15,000 | 39,200 |
| 26 | -- | 24,000 | 40,000 |
| 27 | 1.1 | 21,000 | 45,300 |
| 28 | -- | 24,000 | 43,800 |
| 29 | -- | 21,000 | 42,200 |
| 30 | -- | 46,000 | 40,800 |
| Oct. 1 | -- | 24,000 | 38,500 |
| 2 | -- | 110,000 | 43,000 |
| Median values | 0.9 | 41,000 | |

a/ Data for 1950 collected through Lower Missouri River Investigation conducted cooperatively by State Health Departments of Iowa, Kansas, Missouri, Nebraska, and South Dakota, and the Public Health Service.

Table 1. (cont.)

Florence pumping station (Omaha, Nebr.) laboratory data 1952[a]

| Day (1952) | B.O.D. (ppm.) | Coliform (M.P.N./100 ml.) | Missouri R. discharge (c.f.s.) |
|---|---|---|---|
| Sept. 13 | -- | 9,300 | 30,300 |
| 14 | -- | 210,000 | 31,300 |
| 15 | -- | 24,000 | 30,800 |
| 16 | 0.6 | 43,000 | 30,300 |
| 17 | -- | 14,000 | 30,300 |
| 18 | -- | 43,000 | 27,400 |
| 19 | -- | 20,000 | 26,000 |
| 20 | -- | 43,000 | 26,600 |
| 21 | -- | 7,300 | 27,400 |
| 22 | -- | 9,300 | 27,700 |
| 23 | -- | 9,300 | 29,300 |
| 24 | -- | 4,300 | 29,800 |
| 25 | 0.2 | 15,000 | 29,800 |
| 26 | -- | 15,000 | 29,800 |
| 27 | 0.6 | 24,000 | 29,300 |
| 28 | 0.25 | 46,000 | 28,900 |
| 29 | 0.15 | 9,300 | 28,900 |
| 30 | 0.15 | 7,500 | 28,900 |
| Oct. 1 | -- | 4,300 | 28,900 |
| 2 | 0.90 | 4,600 | 30,300 |
| 3 | -- | 4,600 | 30,300 |
| 4 | 0.70 | 24,000 | 30,300 |
| Median values | 0.4 | 14,500 | |

a/ 1952 laboratory data furnished by Metropolitan Utilities water laboratory.

Table 2.

Bellevue, Nebraska, Power Plant - Laboratory data 1950[a]

| Time 1950 Day | Hour | B.O.D. ppm. | Coliform M.P.N./ 100 ml. | Missouri R. discharge c.f.s. |
|---|---|---|---|---|
| Mar. 15 | 1:30 pm | 7.1 | 2,100 | 20,000 |
| June 14 | 1:18 pm | 8.4 | 110,000 | 31,000 |
| Aug. 16 | 1:40 pm | 5.8 | 1,100,000 | 42,000 |
| 23 | 1:30 pm | 6.4 | 43,000 | 41,000 |
| 30 | 1:15 pm | 4.1 | 75,000 | 34,000 |
| Sept. 6 | 1:45 pm | 3.5 | 93,000 | 32,000 |
| 13 | 1:10 pm | 4.1 | 240,000 | 30,000 |
| 20 | 1:55 pm | 3.5 | > 1,100,000 | 30,000 |
| Nov. 15 | 1:20 pm | 5.2 | 43,000 | 42,000 |
| Median | | 5.8 | 75,000 | |

a/ Data for 1950 collected through Lower Missouri River Investigation conducted cooperatively by the State Health Departments of Iowa, Kansas, Missouri, Nebraska and South Dakota, and the Public Health Service. Data shown here include only samples collected during periods of stream flow ranging from 20,000 c.f.s. to 45,000 c.f.s.

Table 2. (cont.)

Bellevue, Nebraska, Power Plant - Laboratory data 1952[a]

| Time 1952 Day | Hour | B.O.D. ppm. | Coliform M.P.N./ 100 ml. | Missouri R. discharge c.f.s. |
|---|---|---|---|---|
| Sept. 22 | 2:40 pm | -- | 110,000 | 27,700 |
| | 8:30 pm | -- | 230,000 | |
| 23 | 4:12 am | 35.3 | 460,000 | 29,300 |
| | 1:10 pm | 17.3 | 434,000 | |
| | 7:25 pm | 43.0 | 93,000 | |
| | 4:01 am | 19.5 | 93,000 | |
| 24 | 12:40 pm | 12.7 | 43,000 | 29,800 |
| | 6:20 pm | 13.5 | 110,000 | |
| 25 | 4:11 am | 17.0 | 110,000 | 29,800 |
| | 11:30 am | 48.0 | 43,000 | |
| | 6:25 pm | 30.5 | 1,100,000 | |
| 26 | 4:11 am | 13.0 | 230,000 | 29,800 |
| | 11:20 am | 10.5 | 43,000 | |
| | 6:00 pm | 6.0 | 15,000 | |
| 27 | 4:15 am | 21.0 | 93,000 | 29,300 |
| | 11:25 am | 6.0 | 46,000 | |
| | 6:00 pm | 24.0 | 240,000 | |
| 28 | 6:15 am | 18.7 | 150,000 | 28,900 |
| | 12:00 M | 14.7 | 23,000 | |
| | 5:10 pm | 17.8 | 43,000 | |
| 29 | 5:00 am | 18.2 | 93,000 | 28,900 |
| | 11:25 am | 9.2 | 75,000 | |
| | 5:55 pm | 12.0 | 230,000 | |
| 30 | 4:03 am | 11.3 | 230,000 | 28,900 |
| | 12:40 pm | 5.0 | 43,000 | |
| | 6:20 pm | 32.7 | 150,000 | |
| Oct. 1 | 3:40 am | 11.7 | 23,000 | 28,900 |
| | 11:22 am | 10.0 | 23,000 | |
| | 5:30 pm | 8.7 | 43,000 | |
| Median | | 18.0 | 160,000 | |

a/ From laboratory data furnished by Nebraska Department of Health.

Table 3.

Nebraska City, Nebraska, Water Plant Intake - Laboratory data 1950[a]

| Time 1950 Day | Hour | B.O.D. ppm. | Coliform M.P.N. / 100 ml. | Missouri R. discharge c.f.s. |
|---|---|---|---|---|
| Jan. 11 | 11:00 am | 3.0 | 7,500 | 11,600 |
| Feb. 2 | 12:10 pm | 1.0 | 24,000 | 11,600 |
| 22 | -- | 2.9 | 4,300 | 16,000 |
| Sept. 6 | 10:45 am | 4.6 | 240,000 | 34,300 |
| 20 | 11:00 am | 2.9 | 93,000 | 33,000 |
| Nov. 15 | 11:15 am | 4.2 | 9,100 | 43,600 |
| Median | | 5.0 | 58,500 | |

a/ Data for 1950 collected through Lower Missouri River Investigation conducted cooperatively by the State Health Departments of Iowa, Kansas, Missouri, Nebraska, and South Dakota and the Public Health Service. Data shown here includes only samples collected during periods of stream discharge below 45,000 c.f.s.

Table 3. (cont.)

Nebraska City, Nebraska, Water Plant Intake - Laboratory data 1952[a]

| Time 1952 Day | Hour | B.O.D. ppm. | Coliform M.P.N. / 100 ml. | Missouri R. discharge c.f.s. |
|---|---|---|---|---|
| Sept. 22 | 3:50 pm | -- | 4,300 | 30,300 |
| | 10:00 pm | | 23,000 | |
| 23 | 5:30 am | 18.5 | 460,000 | 32,600 |
| | 2:30 pm | 17.0 | 240,000 | |
| | 8:37 pm | 10.5 | 75,000 | |
| 24 | 5:13 am | 16.0 | 43,000 | 35,000 |
| | 1:50 pm | 12.0 | 240,000 | |
| | 7:35 pm | 9.4 | 75,000 | |
| 25 | 5:16 am | 12.2 | 43,000 | 35,000 |
| | 12:30 pm | 24.5 | 1,500,000 | |
| | 7:30 pm | 29.0 | 93,000 | |
| 26 | 5:08 am | 9.5 | 240,000 | 34,200 |
| | 12:35 pm | 17.0 | 43,000 | |
| | 7:15 pm | 6.0 | 93,000 | |
| 27 | 5:10 am | 14.5 | 230,000 | 32,600 |
| | 12:30 pm | 5.0 | 1,100,000 | |
| | 7:30 pm | 17.3 | 43,000 | |
| 28 | 7:05 am | 12.7 | 150,000 | 31,800 |
| | 1:10 pm | 13.2 | 43,000 | |
| | 6:37 pm | 12.2 | 23,000 | |
| 29 | 6:00 am | 6.5 | 43,000 | 31,000 |
| | 12:35 pm | 6.3 | 150,000 | |
| | 6:55 pm | 2.8 | 43,000 | |
| 30 | 5:08 am | 10.7 | 93,000 | 32,600 |
| | 2:00 pm | 7.5 | 230,000 | |
| | 7:35 pm | 11.5 | 75,000 | |
| Oct. 1 | 4:45 am | 9.7 | 43,000 | 33,400 |
| | 12:30 pm | 16.5 | 430,000 | |
| | 7:30 pm | 5.5 | 23,000 | |
| Median | | 12.0 | 93,000 | |

a/ From laboratory data furnished by Nebraska Department of Health.

Table 4.

Total bacteria (37°C), per ml. - St. Joseph, Missouri water plant*

| Date 1952 | Total bacteria count (37°C) per ml. | Date 1952 | Total bacteria count (37°C) per ml. |
|---|---|---|---|
| Sept. 7 | - | Oct. 1 | 150,000 |
| 8 | 135,000 | 2 | 220,000 |
| 9 | 86,000 | 3 | 320,000 |
| 10 | 150,000 | 4 | - |
| 11 | 15,000 | 5 | - |
| 12 | - | 6 | 190,000 |
| 13 | - | 7 | 250,000 |
| 14 | - | 8 | 255,000 |
| 15 | 113,000 | 9 | 200,000 |
| 16 | 80,000 | 10 | - |
| 17 | 150,000 | 11 | 200,000 |
| 18 | 130,000 | 12 | - |
| 19 | - | 13 | 320,000 |
| 20 | - | 14 | 160,000 |
| 21 | - | 15 | Spreader |
| 22 | 236,000 | 16 | 512,000 |
| 23 | 200,000 | 17 | - |
| 24 | 200,000 | 18 | 366,000 |
| 25 | 210,000 | 19 | 149,000 |
| 26 | 300,000 | 20 | 150,000 |
| 27 | - | | |
| 28 | - | | |
| 29 | - | | |
| 30 | 250,000 | | |

* Data provided by St. Joseph, Missouri, water department.